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**Workplace atmospheres — Short term  
detector tube measurement systems  
— Requirements and test methods**

*Air des lieux de travail — Systèmes de mesurage par tube détecteur à  
court terme — Exigences et méthodes d'essai*

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is ISO/TC 146, *Air quality*, Subcommittee SC 2, *Workplaces atmospheres*.

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## Introduction

Many short-term detector tube measurement systems consist of a (length-of-stain) detector tube connected to an associated detector tube pump. When workplace air containing a particular chemical agent is drawn through the detector tube, a colour change takes place corresponding to the concentration.

Such short-term detector tube measurement systems have many applications. This International Standard refers to detector tubes used for workplace air monitoring. These detector tubes can be used for measurement tasks such as follows:

- determination of the presence or absence of an analyte;
- finding the approximate range of concentration;
- determination of the efficiency of control measurements;
- determination of emission sources and emission changes in time;
- determination of compliance with ceiling or short-term limit values, as long as the device covers the reference time period and the precision requirements for the measurement.

To cover the possible range of concentration that can be encountered in the workplace, a combination of two or more measurements using detector tubes with restricted but complementary and overlapping measuring ranges can also be used.

This International Standard will enable the manufacturers, test houses, certification bodies, and the users to adopt a consistent approach to the assessment of performance of short-term detector tube measurement systems.

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# Workplace atmospheres — Short term detector tube measurement systems — Requirements and test methods

## 1 Scope

This International Standard specifies requirements and test methods under prescribed laboratory conditions for length-of-stain detector tubes and their associated pump (detector tube measurement system) used for short-term measurements of the concentration of specified chemical agents in workplace air.

This International Standard is not applicable to measurements made to demonstrate compliance with long-term limit values to personal exposure with a reference period of more than 15 min.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6141, *Gas analysis — Requirements for certificates for calibration gases and gas mixtures*

ISO 6142, *Gas analysis — Preparation of calibration gas mixtures — Gravimetric method*

ISO 6143, *Gas analysis — Comparison methods for determining and checking the composition of calibration gas mixtures*

ISO 6144, *Gas analysis — Preparation of calibration gas mixtures — Static volumetric method*

ISO 6145-1, *Gas analysis — Preparation of calibration gas mixtures using dynamic volumetric methods — Part 1: Methods of calibration*

ISO 6145-4, *Gas analysis — Preparation of calibration gas mixtures using dynamic volumetric methods — Part 4: Continuous syringe injection method*

ISO 6145-6, *Gas analysis — Preparation of calibration gas mixtures using dynamic volumetric methods — Part 6: Critical orifices*

ISO 6145-10, *Gas analysis — Preparation of calibration gas mixtures using dynamic volumetric methods — Part 10: Permeation method*

ISO 9169, *Air quality — Definition and determination of performance characteristics of an automatic measuring system*

IEC 60079-0, *Explosive atmospheres – Part 0: Equipment – General requirements*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

**3.1**  
**(length-of-stain) detector tube**

transparent tube containing chemical reagents in which a colour change is produced when an air sample is drawn through it

Note 1 to entry: The length of the stain produced, relative to a graduated scale, provides a measure of the concentration of a specific chemical agent in air.

Note 2 to entry: Some detector tubes are designed to work in two stages. In that case, a pre-tube and an analyser tube are used in series to produce one measurement.

[SOURCE: EN 1540:2011, 3.2.4, modified — “glass tube” replaced by “transparent tube” and Note 2 to entry added.]

**3.2**  
**short-term detector tube**

detector tube category that provides a means of obtaining a rapid measurement of the concentration of a specified chemical agent in air

Note 1 to entry: The averaging period of the measurement can vary from a few seconds up to about 15 min depending on the measurement system and the target concentration of the analyte.

**3.3**  
**detector tube pump**

device for pulling air through a detector tube

Note 1 to entry: Detector tube pumps can be manually or mechanically driven stroke pumps or piston pumps.

Note 2 to entry: Other types of detector tube pumps which are not dealt with in this International Standard are electrically driven continuous pumps, which can emulate stroke pumps.

**3.4**  
**detector tube measurement system**

complete measurement system consisting of a detector tube and a detector tube pump

**3.5**  
**chemical agent**

chemical element or compound on its own or admixed as it occurs in the natural state or as produced, used, or released, including release as waste, by any work activity, whether or not produced intentionally and whether or not placed on the market

[SOURCE: EN 1540:2011, 2.1.2]

**3.6**  
**(detector tube) measuring range**

scale of concentration which is marked on the detector tube

Note 1 to entry: By increasing or decreasing the number of sampling strokes, the measuring range can be shifted lower or higher.

**3.7**  
**specified (detector tube) measuring range**

concentration range for which the measurement uncertainty of the detector tube is below a given value

**3.8**  
**interferent**

constituent of the (air) sample having an adverse effect on the accuracy of the measurement

[SOURCE: EN 1540:2011, 4.5]



**3.9****test gas**

gas of sufficient stability and homogeneity whose composition is properly established for use to verify the response of a measuring instrument or to validate a measurement method

**3.10****expanded uncertainty**

quantity defining an interval about a result of a measurement, expected to encompass a large fraction of the distribution of values that could reasonably be attributed to the measurand

[SOURCE: EN 1540:2011, 5.2.6]

**3.11****reference period**

specified period of time for which the occupational exposure limit value of a chemical or biological agent applies

Note 1 to entry: The reference period is usually 8 h for long term measurements and 15 min for short-term measurements.

[SOURCE: EN 1540:2011, 2.4.7]

**4 Requirements****4.1 General****iTeh STANDARD PREVIEW**

A functional detector tube measurement system consists of a detector tube and a detector tube pump. All components of the detector tube measurement system should be calibrated by the same manufacturer.

Materials used for the construction of the detector tube pump should be such that it remains functional for a period of at least three years when used in accordance with the manufacturer's instructions.

It is the user's primary responsibility to choose appropriate procedures or devices that meet the requirements of this International Standard. One way of doing this is to obtain information or confirmation from the manufacturer.

It is the manufacturer's primary responsibility to ensure that detector tubes meet the performance requirements under the test conditions specified in [5.6](#).

For workplace air measurements, additional requirements are to be met. For example, see EN 482.[\[4\]](#)

For the specified measuring range, the expanded uncertainty for a detector tube measurement system shall be  $\leq 50\%$  (see EN 482[\[4\]](#)).

**4.2 Detector tubes****4.2.1 Specified measuring range**

The manufacturer shall provide the specified measuring range in which the detector tube complies with the requirement for the expanded uncertainty given in [4.1](#).

**4.2.2 Scale**

The scale shall have a minimum of three calibration marks perpendicular to the axis of the detector tube and shall be marked with concentration values or equivalent. Detector tube scales shall be graduated either in volume per unit volume or mass per unit volume or shall be accompanied by a calibration graph in the same units. The calibration marks shall have a minimum width of 0,3 mm. The starting line

at the beginning of the indicating layer shall be clearly marked. The minimum length of a calibration mark shall be 3 mm and the size of the printed text shall be at least 1,5 mm.

The number of pump strokes or the sample volume required for a particular scale shall be marked on the detector tube.

#### 4.2.3 Evaluation of the stain

The stain shall remain constant and clearly visible for at least 2 min after the end of measurement.

The maximum variation of stain length around the circumference of the tube at the interface between the stained and unstained indicating layer shall not exceed 20 % of the stain length when measured at its maximum length.

NOTE If the end point of the stain fades progressively, the manufacturer's instructions can be consulted for determining reading.

#### 4.2.4 Shelf life

The shelf life of the detector tube, when stored in accordance with the manufacturer's instructions, shall be clearly indicated on the tube packet.

#### 4.2.5 Mechanical strength

Subsequent to the tests carried out in accordance with 6.1.3, the detector tubes shall maintain their integrity.

#### 4.2.6 Transportation temperature stability

After storage of the detector tubes at  $(0 \pm 2) ^\circ\text{C}$  for 24 h and subsequently at  $(60 \pm 2) ^\circ\text{C}$  for 24 h, the detector tubes shall meet the requirements of 4.1 and 4.2.4 after stabilizing to ambient temperature. The manufacturer may specify a maximum temperature range for any kind of transportation. In this case, a test shall be carried out at the temperature specified.

#### 4.2.7 Packing of the detector tubes

If the box contains more than one tube, it shall be re-closable.

If the manufacturer indicates that the tubes shall be protected from light, this shall be ensured by the box.

Subsequent to the tests carried out in accordance with 6.1.3, the box containing the detector tubes shall maintain its integrity.

#### 4.2.8 Interferences

Information on the influence of typical interferences shall be provided by the manufacturer in the instructions for use (see 4.2.11).

#### 4.2.9 Overloading

When the detector tube is tested at a concentration 10 times the upper limit of the scale, the detector tube shall clearly indicate overloading, lasting for at least 2 min.

#### 4.2.10 Environmental influences

The manufacturer shall state the range of temperature and relative humidity for which the specified measuring range is valid. The temperature shall be in a range from at least  $10 ^\circ\text{C}$  to  $30 ^\circ\text{C}$ , and the relative humidity shall be in a range from at least 20 % to 80 %.

#### 4.2.11 Instruction for use for detector tubes

The instruction for use supplied with each box of detector tubes shall contain at least the following information:

- a) operating instructions;
- b) directions for proper handling of a detector tube including opening and fitting it into the detector tube pump;
- c) a statement that the detector tube pump shall be tested for leakage before each use;
- d) general information on the reaction and colour change involved in the system and the levels at which other typical gases and vapours, including water, are likely to interfere to the extent of increasing the measurement uncertainty above the level specified in this International Standard
- e) a statement that additional information on interferences can be provided on request, if possible;
- f) if applicable, information about reagents and reactions that are hazardous;
- g) where the contents of detector tubes present a disposal hazard, a warning to that effect shall be given together with advice that national regulations for disposal of hazardous waste should be followed;
- h) a statement on the time required for the completion of one pump stroke;
- i) information on the evaluation of the reading including calculation of results, e.g. equation, chart, or table used for correction of temperature, atmospheric pressure, and/or humidity, if any;
- j) reference to the operating instructions of the detector tube pump;
- k) specification of the detector tube pump brand or model;
- l) information on storage and transport.

### 4.3 Detector tube pump

#### 4.3.1 General

The requirements given in [4.3.2](#) to [4.3.6](#) shall be verified by the manufacturer.

#### 4.3.2 Stroke volume

When tested in accordance with [6.2.1](#), the detector tube pump shall sample a volume of air within  $(100 \pm 5)$  ml per stroke.

#### 4.3.3 Leakage

The detector tube pump with a closed detector tube connection shall be tight, so that during the first minute of a pump stroke the leakage rate does not exceed 3 ml/min.

#### 4.3.4 Mechanical strength

Subsequent to the test carried out in accordance with [6.2.3](#), the detector tube pump shall meet the requirements given in [4.3.2](#).

#### 4.3.5 Mechanical durability

After execution of 1 000 strokes, the detector tube pump shall meet the requirement of [4.3.2](#) when fitted with the flow resistor given in [5.7](#).

#### 4.3.6 Explosion hazard

If a detector tube pump is claimed by the manufacturer to be suitable for use in areas subject to explosion hazard, electrically driven detector tube pumps shall fulfil the requirements of IEC 60079-0.

#### 4.3.7 Instructions for use for detector tube pumps

The instructions for use supplied with the detector tube pump shall contain at least the following information:

- a) operating instructions;
- b) instructions for testing for leakage before each use;
- c) maintenance instructions;
- d) reference to the operating instructions of the detector tube;
- e) stroke volume;
- f) indication for the end of one stroke;
- g) specification of the detector tube pump brand or model.

### 5 Test conditions

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#### 5.1 General

Parts of the detector tube measurement system which have already been tested according to this International Standard are not required to be tested again.

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#### 5.2 Reagents

Test gas mixtures shall be prepared according to ISO 6141, ISO 6142, ISO 6143, ISO 6144, ISO 6145-1, ISO 6145-4, ISO 6145-6, ISO 6145-10, and ISO 9169. See also Reference [1].

#### 5.3 Apparatus

5.3.1 Usual laboratory apparatus and chemical reagents of analytical grade.

5.3.2 Dynamic or static systems for preparation of test gas mixtures, for example an exposure chamber constructed of inert materials such as glass or PTFE, through which the generated test gas mixture is passed.

5.3.3 Equipment for measuring, controlling and varying systematically the rate of air flow through the generating system and the composition, temperature, and relative humidity of the test gas mixture (see Reference [1]).

#### 5.4 Independent method

An independent validated method shall be used to verify the composition of the test gas mixture used. The composition of the test gas mixture and the related uncertainty shall be given in the test report.

#### 5.5 Generation of test gas mixtures

Prepare test gas mixtures for at least three concentrations, for example at approximately 20 %, 50 %, and 80 % of the specified measuring range, and at the values of temperature, relative humidity, etc. specified in the appropriate test methods in [Clause 6](#). Determine the mean concentration of the test gas